PCI-X 2 Gigabit Fibre Channel and Gigabit Ethernet Performance

Using the HP rp8400 Server with Server Expansion Unit

April 2004

Table of Contents

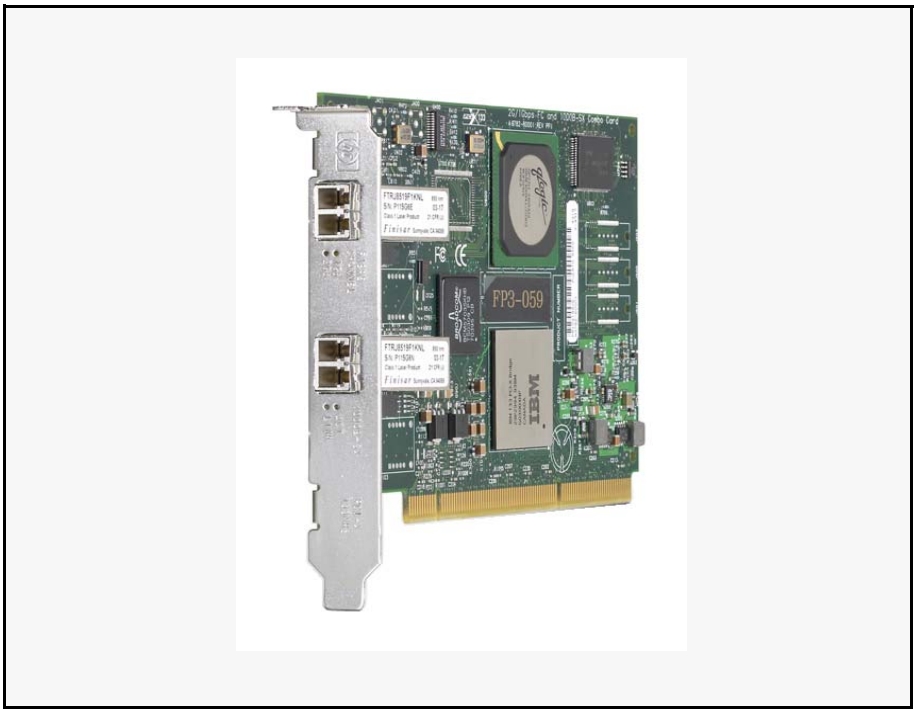
Introduction

This article highlights the superb performance and high availability demonstrated when you install HP's new PCI-X multi-function 2 Gbit/s Fibre Channel and Gigabit Ethernet adapters in HP's award-winning midrange rp8400 servers with Server Expansion Units (SEU). The new A9782A adapter (with fiber-based GigE) and the A9784A adapter (with copper-based GigE) provide the following benefits:

- A single adapter combining 2 Gbit/s Fibre Channel mass storage connectivity and 1000Base-SX or Base-T Gigabit Ethernet networking connectivity.
- Higher port density for I/O slot–constrained systems.
- Higher levels of failover protection, because two multi-function adapters have no single point of failure. The same level of failover protection would require four single-port I/O adapters (2 Fibre Channel and 2 Gigabit Ethernet) that would consume twice the number of I/O slots.

  The adapters also fully support HP Serviceguard and PCI-X/PCI online addition and replacement (**OLAR**).
- PCI-X I/O adapters that are fully backward compatible with PCI 2.2 I/O slots.
- Flexibility for implementing Virtual Partition (**vPars**) configurations.

Figure 1 HP PCI-X 2 Gbit/s Fibre Channel and Gigabit Ethernet Multi-Function Adapter (A9782A shown)



Both the A9782A and A9784A adapters offer the same level of performance and are designed with the following advanced features.

The Fibre Channel port in each adapter:

- runs at either 200 MB/s half-duplex or 400 MB/s full duplex data rates.
- provides boot / dump support and auto speed sensing.
- supports 2 to 200 meter LC-to-LC duplex multimode fibre-optic cable and of course LC-to-SC conversion cables.
- scales up to 16 million SAN nodes.
- operates in full switched fabric Fibre Channel (**FC-SW**) or FC-AL-2, FC-FLA, FC-PLDA, and FC-PI architectures.

The Gigabit Ethernet port in each adapter:

- maximizes server CPU efficiency and increases performance through **TCP**, **UDP**, and **IP checksum protocol off loading**.
- increases network flexibility through support for virtual LANs (**VLAN**s).
- increases throughput through use of HP auto port aggregation (**APA**) or
- improves reliability and failover through the LAN Monitor capability of HP APA.
- is available in a choice of either a 1000 Base-SX version using multi-mode fiber supporting distances of up to 550m or a 1000Base-T version using CAT5 or better UTP cable supporting distances of up to 100m.

HP rp8400 servers with Server Expansion Units (SEU) like the one used in this demonstration are highly dependable, adaptable, and efficient midrange servers for the data center. The results in this paper show that the A9782A and A9784A adapters installed in a server expansion unit like the one on the rp8400 increase your server and data network efficiency while lowering your total cost of ownership.

PCI-X 2 Gigabit Fibre Channel and Gigabit Ethernet Performance Test Results

The Gigabit Ethernet port performance on the A9782A and A9784A was measured with the following traffic types:

- Transmit (Tx) using netperf with socket size of 128K bytes and message size of 32K bytes
- Receive (Rx) using netperf with socket size of 128K bytes and message size of 32K bytes
- Bidirectional (BD) running the Tx and Rx tests concurrently

The Fibre Channel port performance on the A9782A and A9784A was measured with the following traffic types:

- Read (Rd) using diskbench with block size of 128K bytes
- Write (Wr) using diskbench with block size of 128K bytes
- Bidirectional (BD) running the Rd and Wr tests concurrently

The following charts show the overall performance of one PCI-X multi-function 2 Gigabit Fibre Channel and Gigabit Ethernet adapter in each 1, 2, or 4-cell, 16-way rp8400 with Server Expansion Unit (SEU). In the enclosed charts:

- the Gigabit Ethernet throughput numbers are shown in *Megabits per second*, and
- the Fibre Channel throughput numbers are shown in *Megabytes per second*.

For each measured traffic type (for example, GigE Tx), the results for that traffic type are shown alongside a comparison of that traffic type when running in conjunction with the adjacent port running in bidirectional mode (for example, GigE Tx plus Fibre Channel bidirectional). These comparisons basically show a single port compared to both ports operating at the same time. The results of PCI-66 testing are also described though not shown in graphs.

The following charts can be used to compare performance when 1, 2, and 4 cells are configured per partition.

Throughput

GigE Traffic Alone Compared to GigE Traffic in Conjunction with FC Bidirectional

Figure 2 PCI-X GigE Rx Performance Compared to: Rx + FC BD

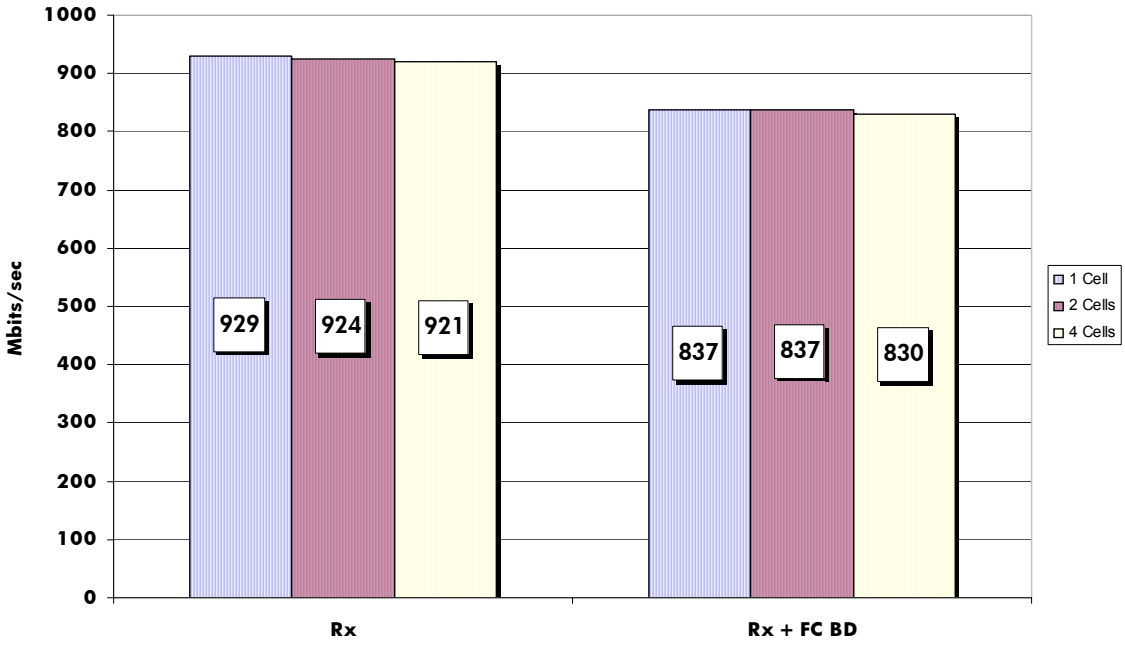


Figure 2 shows PCI-X **Gigabit Ethernet** Receive (Rx) performance. With 1, 2, or 4 cells configured, the following throughput rates were achieved:

- Receive throughput on the GigE port with no Fiber channel traffic on a 1 cell partition is an excellent 929 Mbits/sec. As the partition size is increased by adding up to 3 more cells, receive throughput shows no significant drop in performance. A similar pattern emerges when GigE receive and FC bidirectional are combined. GigE receive throughput is 837 Mbits/sec with no significant change as partition size is increased.
- When tested in a PCI-66 slot, the performance results for receive only throughput are identical to PCI-X performance. When GigE receive and FC bidirectional traffic are combined, PCI-66 performance is 585 Mbits/sec with no significant change as partition size increases. The decreased performance seen when both ports are active on the A9782A/A9784A is a result of the bandwidth limitation of the PCI-66 technology and is not due to a limitation in the adapter.

Figure 3 PCI-X GigE Tx Performance Compared to: Tx + FC BD

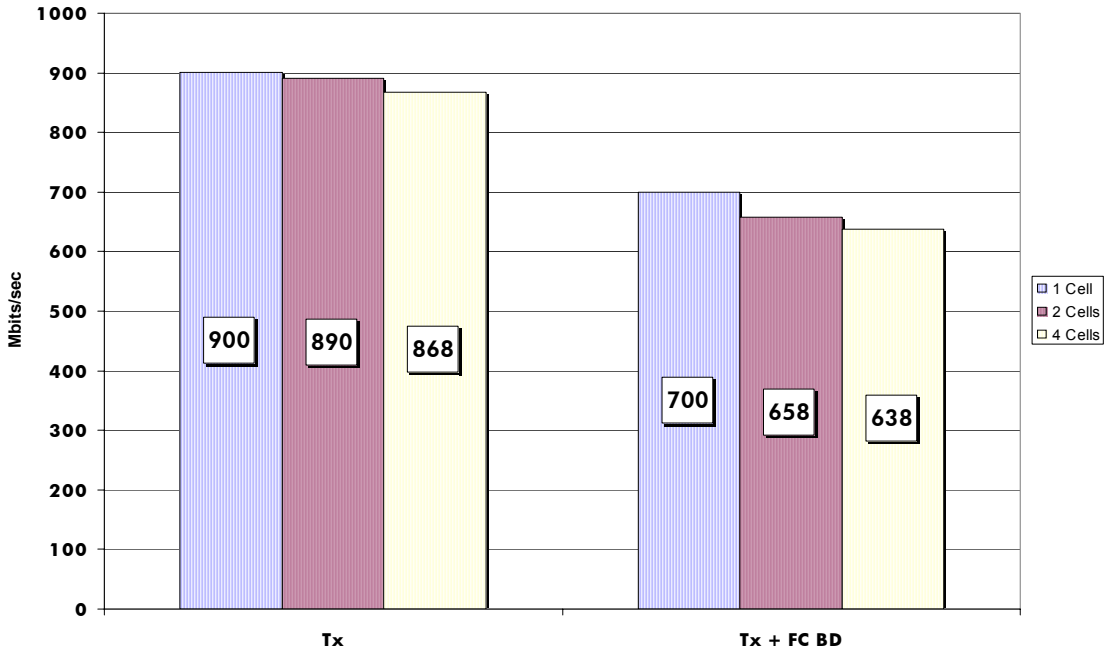


Figure 3 shows PCI-X **Gigabit Ethernet** Transmit (Tx) performance. With 1, 2, or 4 cells configured, the following throughput rates were achieved:

- Transmit throughput on the GigE port with no Fiber channel traffic on a 1 cell partition is 900 Mbits/sec. As the partition size is increased by adding up to 3 additional cells, transmit throughput decreases to 868 Mbits/sec.

  A similar pattern emerges when GigE transmit and FC bidirectional are combined. GigE transmit throughput is 700 Mbits/sec on a 1 cell partition and decreases to 638 Mbits/sec as partition size is increased to 4 cells.

- When tested in a PCI-66 slot, the performance results *for transmit only* throughput showed no decrease in performance when compared to PCI-X. When GigE transmit and FC bidirectional traffic are combined, PCI-66 performance is 440 Mbits/sec with no significant change as partition size increases. The decreased performance seen when both ports are active on the A9782A/A9784A is a result of the bandwidth limitation of the PCI-66 technology and is not due to a limitation in the adapter.

Figure 4 PCI-X GigE BD Performance Compared to: BD + FC BD

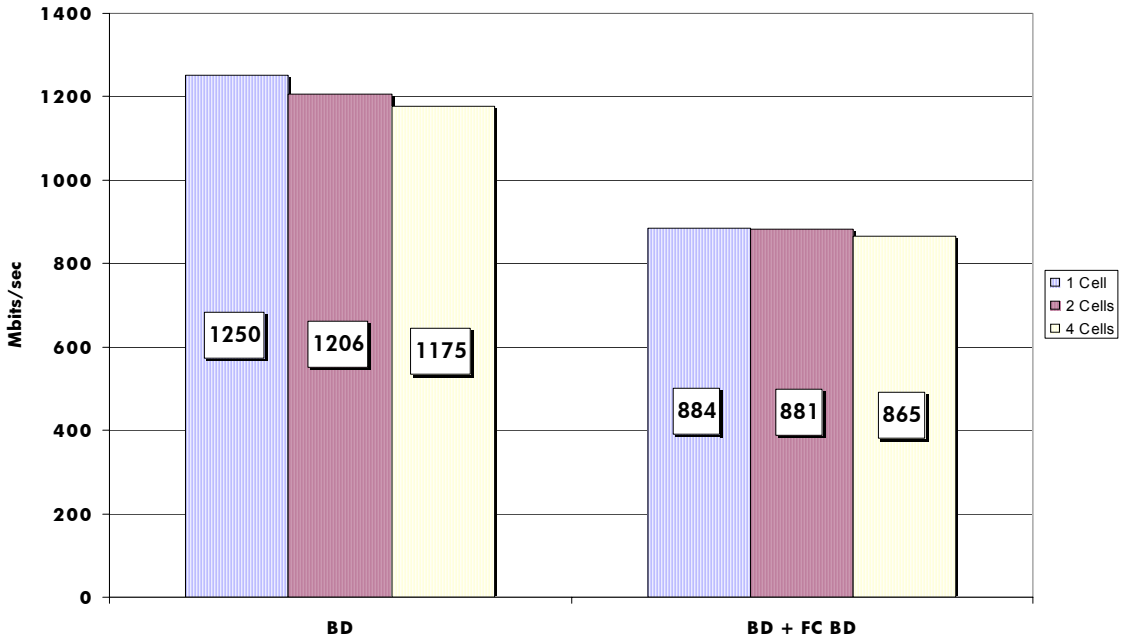


Figure 4 shows PCI-X **Gigabit Ethernet** Bidirectional (BD) performance. With 1, 2, or 4 cells configured, the following throughput rates were achieved:

- Bidirectional throughput on the GigE port with no Fiber channel traffic on a 1 cell partition is 1250 Mbits/sec. As the partition size is increased by adding up to 3 more cells, bidirectional throughput decreases to 1175 Mbits/sec. A similar pattern emerges when GigE bidirectional and FC bidirectional are combined. GigE bidirectional throughput is 884 Mbits/sec on a 1 cell partition and decreases to 865 Mbits/sec as partition size is increased to 4 cells. You see a more significant decrease on the A9782A/A9784A when both ports are active due to the inherent bandwidth limitations of the PCI-X technology when both links are carrying full bidirectional traffic.
- When tested in a PCI-66 slot the performance results for bidirectional only throughput showed no decrease in performance when compared to PCI-X. When GigE bidirectional and FC bidirectional traffic are combined, PCI-66 performance is 592 Mbits/sec with no significant change as partition size increases. The decreased performance seen when both ports are active on the A9782A/A9784A is a result of the bandwidth limitation of the PCI-66 technology and is not due to a limitation in the adapter.

FC Traffic Alone Compared to FC Traffic in Conjunction with GigE Bidirectional

Figure 5 PCI-X Fibre Channel Read Performance

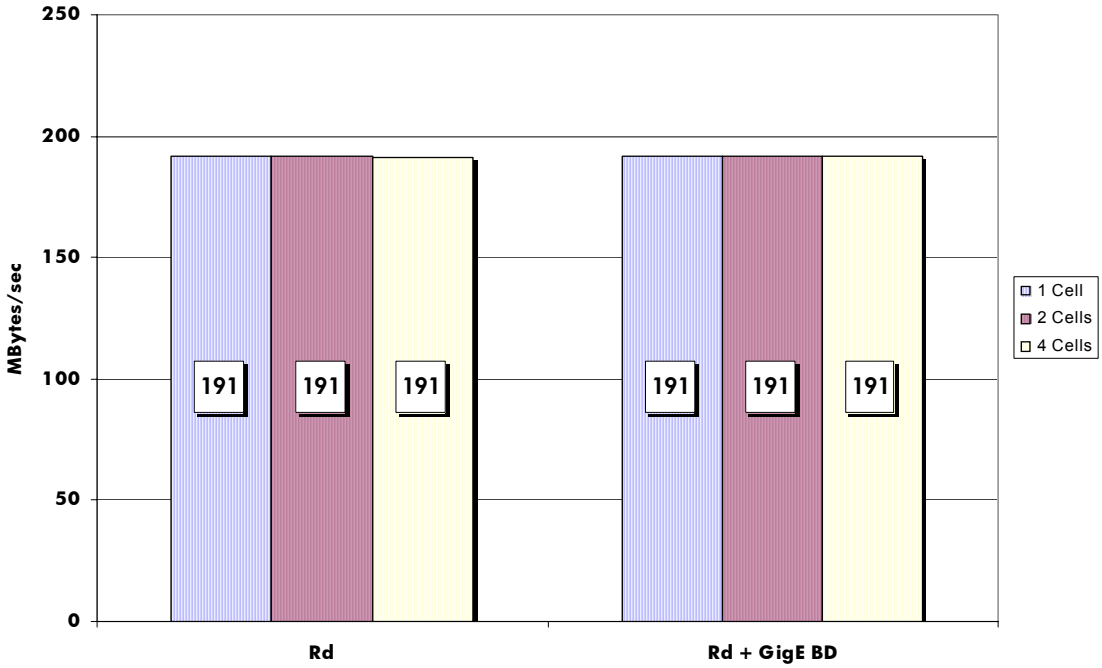


Figure 5 shows PCI-X **Fibre Channel** Read (Rd) performance. With 1, 2, or 4 cells configured, the following throughput rates were achieved:

- Read throughput on the FC port with no GigE traffic on a 1 cell partition is an excellent 191 MBytes/sec. As the partition size is increased by adding up to 3 more cells, read throughput shows no drop in performance. A similar pattern emerges when FC read and GigE bidirectional are combined. FC read throughput is 191 MBytes/sec with no change as partition size is increased.
- When tested in a PCI-66 slot, the performance results for read only throughput are identical to PCI-X performance. When FC read and GigE bidirectional traffic are combined, PCI-66 performance is 157 MBytes/sec with no change as partition size increases.

Figure 6 PCI-X Fibre Channel Write Performance

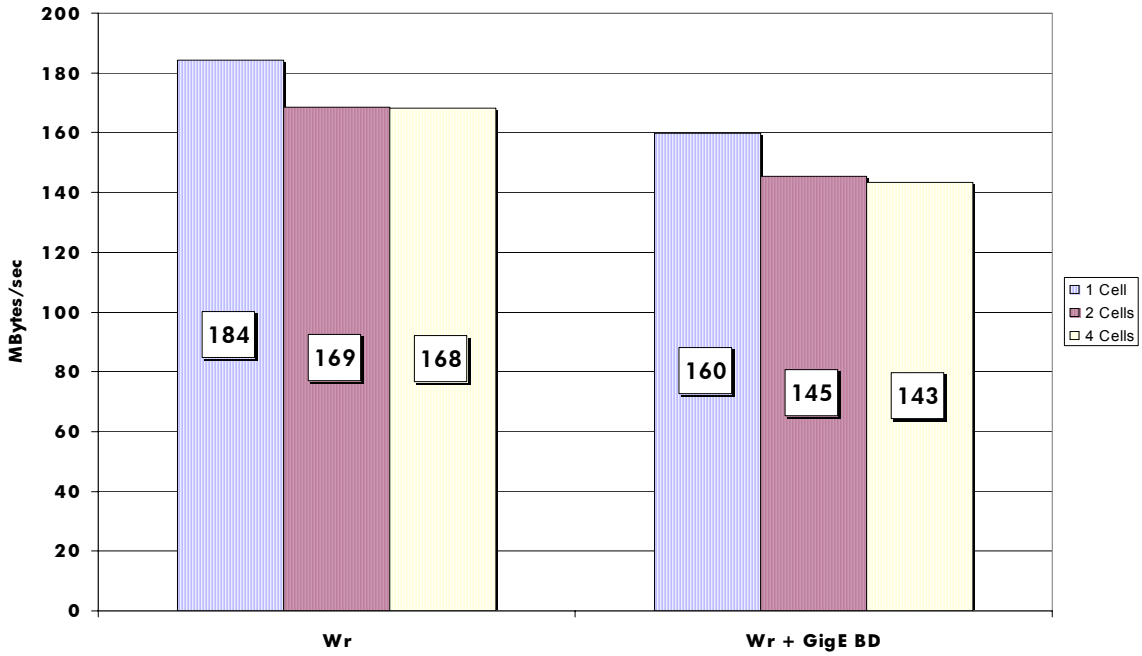


Figure 6 shows PCI-X **Fibre Channel** Write (Wr) performance. With 1, 2, or 4 cells configured, the following throughput rates were achieved:

- Write throughput on the FC port with no GigE traffic on a 1 cell partition is an excellent 184 MBytes/sec. As the partition size is increased by adding up to 3 more cells, write throughput decreases to 168 MBytes/sec. A similar pattern emerges when FC write and GigE bidirectional are combined. FC write throughput is 160 MBytes/sec on a 1 cell partition and decreases to 143 MBytes/sec as partition size is increased to 4 cells.
- When tested in a PCI-66 slot, the performance results for write only throughput showed no decrease in performance when compared to PCI-X. When FC write and GigE bidirectional traffic are combined, PCI-66 performance is 117 MBytes/sec. As you increase the partition size by adding up to 3 more cells, write throughput decreases to 90 MBytes/sec. The decreased performance seen when both ports are active on the A9782A/A9784A is a result of the bandwidth limitation of the PCI-66 technology and is not due to a limitation in the adapter.

Figure 7 PCI-X Fibre Channel Bidirectional Performance

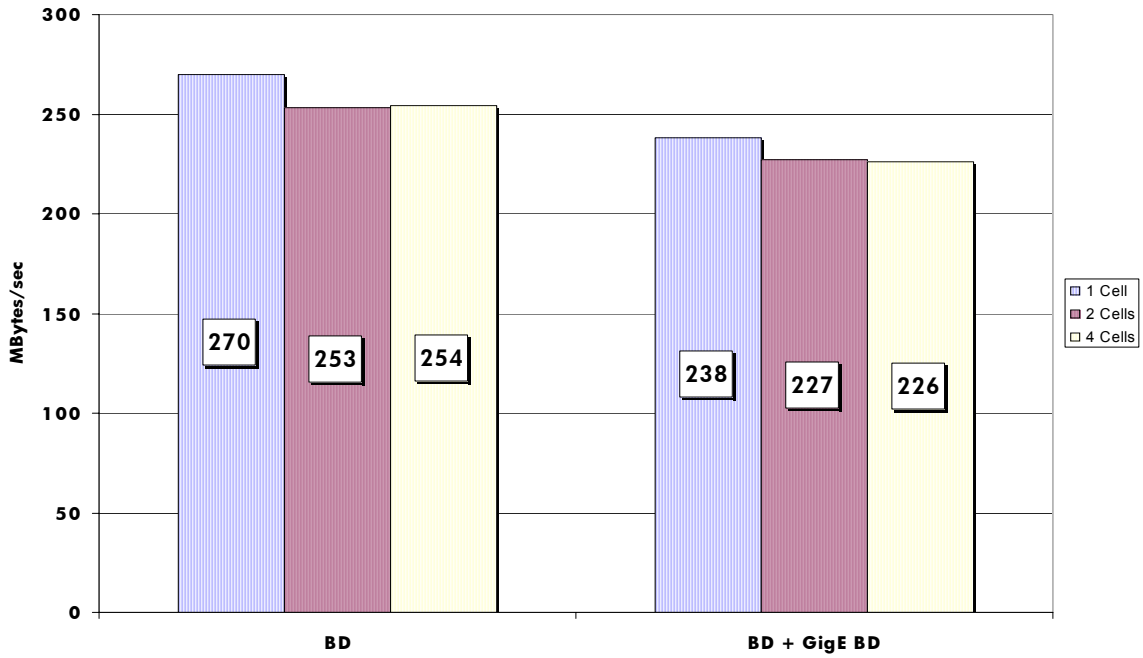


Figure 7 shows PCI-X **Fibre Channel** Bidirectional (BD) performance. With 1, 2, or 4 cells configured, the following throughput rates were achieved:

- Bidirectional throughput on the FC port with no GigE traffic on a 1 cell partition is 270 MBytes/sec. As the partition size is increased by adding up to 3 more cells, Bidirectional throughput decreases to 254 MBytes/sec. A similar pattern emerges when FC bidirectional and GigE bidirectional are combined. FC bidirectional throughput is 238 MBytes/sec on a 1 cell partition and decreases to 226 MBytes/sec as partition size is increased to 4 cells.
- When tested in a PCI-66 slot, the performance results for Bidirectional only throughput showed a similar pattern when compared to PCI-X. Bidirectional throughput on the FC port with no GigE traffic on a 1 cell partition is 250 MBytes/sec. As you increase the partition size by adding up to 3 more cells, bidirectional throughput decreases to 230 MBytes/sec. When FC bidirectional and GigE bidirectional traffic are combined, PCI-66 performance is 155 MBytes/sec. As you increase the partition size by adding up to 3 more cells, bidirectional throughput decreases to 127 MBytes/sec. The decreased performance seen when both ports are active on the A9782A/A9784A is a result of the bandwidth limitation of the PCI-66 technology and is not due to a limitation in the adapter.

Performance Highlights

The A9782A and A9784A adapters when installed in an rp8400 with Server Expansion Unit (SEU) provide exceptional connectivity, reliability, and flexibility for networking and mass storage.

When both ports on the adapter are concurrently transferring data, the adapter provides excellent fiber channel performance and good Gigabit Ethernet performance. The reduced Gigabit Ethernet performance is due to the inherent bandwidth limitations of the PCI-X or PCI-66 buses through which the adapter is connected.

When only one port on the adapter is actively transferring data, the active port provides excellent performance.

The adapters can be configured and used to best meet your business needs as described in the "Suggested Use" section that follows.

Suggested Use

If you use both functions (ports) of an A9782A or A9784A, this obviously provides maximum connectivity. The data in this paper shows that when both functions of the A9782A/A9784A are in use, (as opposed to a single function), the limits of the PCI and PCI-X technologies can be reached, reducing performance. In summary:

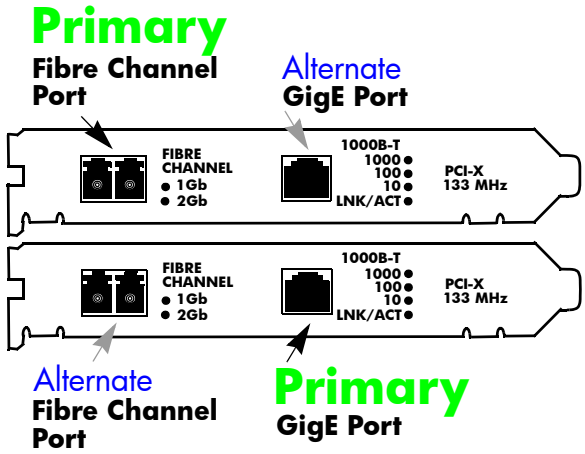
- Where *connectivity* is a higher priority than performance, use the adapters with both functions operating concurrently.
  However:
- Where *performance* and *high availability* are the highest priority, HP recommends that you use 2 adapters in a hot-failover configuration. See the next section and Figure 8 for more.

Achieving Best Performance and High Availability

To get the best performance as well as high availability using the A9782A/A9784A, HP recommends the following:

- As shown in Figure 8, you can use two multi-function adapters together to achieve both the best performance *and* high availability. In the event of a system slot failure or other fabric / network failure, the alternate data port can take over – maximizing system up time!

Figure 8 **Two HP Multi-Function Adapters Configured to Provide Both High Availability and Best Performance**



NOTE The following recommendations assume that your systems are also configured with failover software such as HP Serviceguard and Logical Volume Manager. Consult docs.hp.com for full details on configuring your products for high availability.

— Use only 1 port on each of two adapters as the "primary" port for that technology's normal data traffic. The second port on the same adapter becomes an "alternate" or hot-standby for the other adapter.

— Connect the Fibre Channel port from each of the two adapters to a different storage area network (SAN) by connecting through different FC switches--which then connect to different ports on the mass storage device. Failover between the two paths is managed by logical volume manager (LVM) PVLinks (for alternate paths) or SecurePath.

— Connect each GigE port through a different network switch and ensure that the switches are bridged to the same IP subnet. Failover between the two network paths is managed by Serviceguard's local network failover capability.

— Connect the built-in network ports on multiple rp8400s to a private subnet and use them for a dedicated heartbeat for Serviceguard.

This configuration protects you from a failure of the FC port on either adapter, a failure of either FC switch, the failure of either controller on the mass storage device or any single FC cable failure. It also protects you from the failure of the GigE network port on either adapter, a failure of either network switch, or the failure of any single network cable.

Suggested Use

- Use PCI-X mode as opposed to PCI mode. The primary PCI-X bus running at 133MHz PCI-X with 64-bit bus width will yield the best results and the performance comparable to that shown in this paper. HP tested the A9782A and A9784A adapters in PCI mode, but because PCI performance is lower than PCI-X performance, HP recommends using these adapters in PCI-X mode rather than PCI. In the system under test, the PCI-X slots are the slots located in the rp8400 Server Expansion Unit (SEU) not the base rp8400 system. See "Test Details: Test Configuration" for more details on the PCI-X slots of the rp8400 SEU. Please see your sytems' documentation for the location of the PCI-X slots in your systems.
- On an rp8400 Server with Server Expansion Unit (SEU), configure each cell in the SEU with a multiple of 8 equal capacity dual inline memory modules (DIMMs) to take advantage of memory interleaving. Distribute the 8 DIMMs evenly across the system's two busses.

Test Details

The following subsections describe the hardware and software used in testing and the methods of testing.

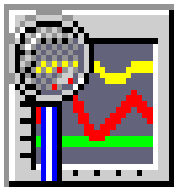
Test Details: Products Used in Testing

The following products were used for the performance measurement tests:

Table 1 Products Used in the Performance Measurement Tests

Server Tested		rp8400 with Server Expansion Unit (SEU). A6434A SEU shown. Four, 750 MHz CPUs per cell (16 total) 16 GB RAM (4GB per cell) Operating System - HP-UX 11i version 1 (B.11.11.0312)
Adapter Tested		A9782A/A9784A 2 Gigabit Fibre Channel and Gigabit Ethernet adapter PCI-X (64-bit, 133MHz) LAN Driver version – Gigether-01 B.11.11.11 FC Driver version – FibrChanl-01 B.11.11.02
Clients generating the test load for Gigabit Ethernet		Four j6000 workstations Two, 552 MHz CPUs each Operating System - HP-UX 11i version 1 (B.11.11.0303.4) One A4926A PCI 1000Base-SX adapter per j6000 LAN Driver version – GigEther-00 B.11.11.14
HP StorageWorks DS2405 Fibre Channel Disk Systems		Four DS2405 FC disk enclosures with a mix of drives for Fibre Channel tests

Table 1 Products Used in the Performance Measurement Tests (Continued)

Benchmark software for Gigabit Ethernet tests		Netperf is the benchmark software suite that generated LAN traffic for the Gigabit Ethernet performance tests. For more information about netperf or to get a free copy of netperf, go to http://www.netperf.org
Benchmark software for Fibre Channel tests		Diskbench (db) is the benchmark suite that generated disk read and write traffic for the FC tests.

Test Details: Test Configuration

The test configuration consists of a 16-way (750 MHz) rp8400 with Server Expansion Unit (SEU) cabinet with 16 Gigabytes of system memory and one A9782A PCI-X 2 Gigabit Fibre Channel and Gigabit Ethernet adapter. The single adapter performance was then measured in a system configured with 1 cell per partition, 2 cells per partition, and 4 cells per partition. The A9782A /A9784A are 3.3 volt adapters "keyed" so that they only fit in the correct system slots. The PCI-X slots in the system under test and in all rp8400s are the slots located in the rp8400 Server Expansion Unit (SEU) *not* the base rp8400 system. The slots labelled 1 through 6 in each of the two card cages of the base system are PCI 3.3 volt slots. Slots 7 and 8 in the base system are PCI 5 volt slots, and these adapters cannot be used in 5 volt slots. All 16 of the slots in the SEU cabinet are PCI-X slots.

The Gigabit Ethernet test load was generated by connecting the Gigabit Ethernet port on the adapter in the rp8400 SEU to one HP 9304M Procurve Routing Switch. Four 2-way j6000 each containing a single PCI 1000Base-SX adapter were connected to the switch.

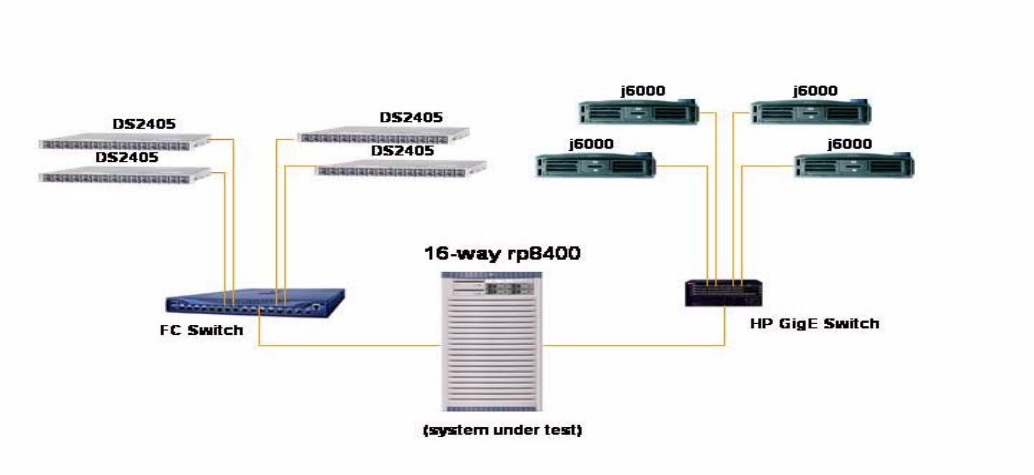
The Fibre Channel test load was generated by connecting the Fibre Channel port on the adapter in the rp8400 SEU to a Brocade™ Fibre Channel switch. Four HP DS2405 Disk Systems capable of handling 2Gbyte/s Fibre Channel were evenly connected to the switch. The switch ports were configured as QuickLoop (QL) to emulate a private loop.

NOTES:

- The networking and I/O performance of the A9782A is identical to the A9784A.
- The observed performance results are consistent across all of the same type of I/O slots of the system.

- The A7109-60001 core I/O adapter in the rp8400 SEU had only minimal site LAN traffic during performance testing.

Figure 9 Test Configuration



Additional Information

For more information about the products described in this paper such as a current list of tested HP products or supported systems, please go to:

http://www.hp.com/products1/unixserverconnectivity/storagesnf2/multifunction_adapters/overview.html.

This paper is the latest in a series of white papers detailing the performance of HP's link and server products. For a complete list of white papers on HP's Fibre Channel and Gigabit Ethernet solutions, go to:

http://docs.hp.com.

Taking the Next Step

With demonstrable performance and high availability, the A9782A / A9784A PCI-X 2 Gigabit Fibre Channel and Gigabit Ethernet adapters installed in an HP server rp8400 with Server Expansion Unit (SEU) are a winning combination. Contact your local HP Sales Representative for a detailed analysis of your specific requirements and needs.

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